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Original Article

Feasibility of Dentascan in planning of implant surgery in posterior maxilla and mandible

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ABSTRACT

Objectives: The present evaluate the feasibility of Computed tomography (Dentascan), in assessment of the implant site in posterior maxilla & mandible.
Material and Methods: data of total 11 patients with 20 implant sites were involved in the present study. Out of the 20 implant sites selected 10 were in posterior maxilla and 10 in posterior mandible. All the patients were routinely examined by panoramic radiography and CT. All images obtained i.e., conventional panoramic radiograph, and film based Dentascan MPR- CT images were evaluated for the detectability of mandibular canal at the mental foramen, 1 cm, 2 cm, and 3 cm posterior to mental foramen. The judgments were then compared by using the four point grading score.
Results: Both the statistical analysis and radiographic observation showed that Dentascan MPR CT gives significantly clearer images at the mental foramen and 1 cm, 2 cm , 3 cm posterior to it. Dentascan also provides significantly better visualization of the vital structures along with the bone density. The panoramic and Dentascan MPR CT images did not show a significant difference in visualization of the crest of alveolar ridge in both maxillary as well as the mandibular arch.
Conclusion: The Dentascan MPR- CT images revealed significantly clearer images as well as better visualization of the vital structures than conventional panoramic radiography. Apart from providing clearer images Dentascan also gives the buccopalatal/buccolingual dimension at the implant site, along with the density of the available bone.

1. Introduction

The modern times of dental implantology was steered in by the innovative work of Branemark and his coworkers. Their research demonstrated the relationship between bone and implant that now is known as osteointegeration. They described osteointegeration in histologic terms as the direct contact of living bone with the implant surface at microscopic level.[1] Since then the use of implant has gained immense popularity and wide acceptance.[2] The placement of dental implants has revolutionized our ability as oral health care practitioner to manage and restore partially edentulous and completely edentulous state[3]. Implant prosthesis offers a more expected treatment outcome than customary restoration.

Despite of the remarkable progress done in the field of implant dentistry, the maxillary and the mandibular posterior regions present unique challenging conditions in rehabilitation as compared to other regions of the jaw.[4] This was shown by longitudinal clinical studies that have reported success rate at 10 years ranging from 81% to 85% for the maxilla and from 98% to 99% for the anterior mandible. The highest failure rate has been reported for the posterior maxilla, which has been attributed to the fact that this area often presents specific problems for the placement of dental implants.[5] The generally poor bone quality frequently faced in this region in combination with inadequate bone volume, related to both the size of the maxillary sinus and resorption of the alveolar ridge have rendered long term success rate for implants less favorable here than in the other region of the jaws. Similarly the preoperative assessment of dental implant site in the posterior segment of the mandible, requires accurate localization of the mandibular canal.[6]

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So for the long term success, it is important to be able to place implants in mandible and maxilla with high degree of precision. The assessment of bone support in endosseous implants is fundamental to the clinical utility of implants for restoration and function. Radiograph are critical tools for assessment of bony architecture and are useful for each of the three phases of implant placement i.e. evaluation, implant treatment and maintenance.[7]

Conventional panoramic radiography is still the most commonly used imaging modality in the treatment planning for implant placement; however they don't provide the precise determination of quantity and quality of the available bone which is critical for the long term success of implants.[8]

Computer Assisted Tomography is the method of choice for achieving the above mentioned goals, as it reveals cross sectional views of the dental arches, allows visualization of inclination of alveolar process, localization of mandibular canal and precise measurements of bone quantity and quality.[9] With these considerations a need was felt to evaluate the accuracy and feasibility of the computed tomography (Dentascan) with panoramic radiography for rehabilitation of edentulous or partially edentulous posterior maxilla and mandible with implants.

2. Material and methods

Total 11 patients involved in this study were aged 18 to 58 years (average age 24 years; all of them were males). Total 20 implant sites were considered in the study. Out of these 10 were in mandible and 10 in maxilla. All patients had been routinely examined using conventional panoramic radiographic machine, EC PROLINE (Planmeca Of Asentajankatu – Helinski Finland). Ten panoramic radiograph had been processed using standard processing conditions.

High resolution,1.5 mm thick axial slices with 1 mm slice interval,120 kVp,120 Ma, 512×512 matrix had been used as the protocol of CT examination. The axial CT data had been transferred to a workstation and reformatted by Dentascan to generate paraxial and panoramic images and printed on films (Kodak T mat). The archived axial CT data were stored on CD- R and transferred to a personal computer with 15.1 in LCD monitor. Paraxial and Panoramic images were reconstructed using Dentascan software.

All images obtained i.e., conventional panoramic radiograph, and film based Dentascan MPR- CT images were evaluated for the detectability of mandibular canal at the mental foramen, 1 cm, 2 cm, and 3 cm posterior to mental foramen. The judgments were then compared. The four point grading score was used for assessment (1 = no display as a result of impossible demarcation from the surrounding tissue 2 = localization of canal/sinus not possible; discontinuity >3 mm; 3 = some artifacts, local bloating/ too narrow/or discontinuation for short distance (1–3 mm); 4 = continuing smooth sharply defined contour.)

For qualitative evaluation of the panoramic radiography with Dentascan, the proximity of the vital structures (maxillary sinus and inferior alveolar canal) was assessed on a four point grading score utilizing the image evaluation questionnaire. The four point grading was used to assess the visualization of the inferior border of the maxillary sinus and the crest of the alveolar ridge at the implant site. Similarly the superior border of the inferior alveolar canal and the crest of mandibular alveolar crest were assessed using the four point grading scale.

Further the assessment of quantity of bone was done by measuring the height and width of bone available for implant placement, by utilizing panoramic radiography and Dentascan. The height of the bone was calculated from crest of the alveolar ridge to the superior border of the inferior alveolar canal for mandible and from the alveolar crest to the floor of the maxillary sinus for maxilla. Similarly the width of the bone was calculated in the mesiodistal direction. Dentascan was utilized to obtain the buccolingual and the buccopalatal dimensions of bone in the mandible and the maxilla respectively. Further Dentascan software was used to calculate the density of the available bone in Hounsfield units and Misch classification was used know the type of bone available for implant placement. Misch classified the type of bone as D1- dense cortical bone(>1250 HU), D2- thick dense to porous bone on crest and course trabecular bone within (850–1250 HU), D3- thin porous cortical bone on crest and fine trabecular bone within (350–850 HU) D4- fine trabecular bone (150–350 HU), D5- immature- non mineralized bone (<150 HU.

3. Results

The distribution of grading score for visibility of mandibular canal according to the radiographic methods (panoramic radiography/Dentascan) in the four regions (at the mental foramen, 1 cm, 2 cm, and 3 cm posterior to mental foramen) (Table 1). The mandibular canal was better visualized with Dentascan MPR-CT than panoramic radiography in all the four regions. Especially at

Table 1
Comparison of Visibility of Mandibular Canal And Mental Fo Ramen in Panoramic Radiograph and Dentascan.

Visibility of mandibular canal and Mental foramen		Poor (1)	Severe limitation (2)	Slightly limited (3)	Excellent (4)	Mean ± SD	P value
At mental foramen	Panoramic radiograph	1 (10.0%)	0	5 (50.0%)	4 (40.0%)	3.20 ± 0.92	0.589
	Dentascan	1 (10.0%	0	3 (30.0%)	6 (60.0%)	3.40 ± 0.97	
At 1 cm from mental foramen	Panoramic radiograph	1 (10.0%)	3 (30.0%)	5 (50.0%)	1 (10.0%)	2.60 ± 0.84	0.009**
	Dentascan	0	0	3 (30.0%)	7 (70.0%)	3.70 ± 0.48	
At 2 cm from mental foramen	Panoramic radiograph	0	2 (20.0%)	5 (50.0%)	3 (30.0%)	3.10 ± 0.74	0.034*
	Dentascan	0	0	3 (30.0%)	7 (70.0%)	3.70 ± 0.48	
At 3 cm from mental foramen	Panoramic radiograph	0	2 (20.0%)	4 (40.0%)	4 (40.0%)	3.20 ± 0.79	0.038*
	Dentascan	0	0	1 (10.0%)	9 (90.0%)	3.90 ± 0.32	

Table 2
Comparison of Vital Structures at Implant Site in Panoramic Radiograph and Dentascan for Maxilla.

Vital structures in maxilla		Poor (1)	Severe limitation (2)	Slightly limited (3)	Excellent (4)	Mean ± SD	P value
Visualization of the inferior border of maxillary sinus	Panoramic radiograph	0	5 (50.0%)	4 (40.0%)	1 (10.0%)	2.60 ± 0.69	0.006**
	Dentascan	0	0	2 (20.0%)	8 (80.0%)	3.80 ± 0.42	
Visualization of the crest of the alveolar ridge	Panoramic radiograph	0	1 (10.0%)	7 (70.0%)	2 (20.0%)	3.10 ± 0.57	0.157
	Dentascan	0	0	7 (70.0%)	3 (30.0%)	3.30 ± 0.48	

the region 1 cm posterior to mental foramen conventional radiograph showed markedly lower percentage of excellent mandibular canal image than the other images.

The Dentascan MPR CT images gave significantly clearer (P value .006) images of the inferior border of the maxillary sinus as compared to the images obtained by panoramic radiography (Table 2). Excellent images of the inferior border of the maxillary sinus could be obtained in only 10% of the panoramic radiographs as compared to the 80% of excellent images obtained in dentascan. Similarly the Dentascan offered significantly clearer images of the superior border of the inferior alveolar canal as compared images obtained by panoramic radiography (P value .003) Figs 1 and 2. Excellent images of the superior border of the inferior alveolar canal could be obtained in only 10% of cases as compared to the 90% of excellent images obtained in dentascan. The dentascan offered clearer visualization of the crest of alveolar ridge in maxilla as well as the mandible (P value .002).

Further the quantity of bone in mandible was assessed by measuring the height of the bone from crest of the alveolar ridge to the superior border of the inferior alveolar canal and also the mesio distal bone available at the implant site, by panoramic radiography and dentascan respectively. The dentascan offers significantly better estimation of the quantity of bone as compared to the panoramic radiograph as shown in Table 3, ($P < .001$). Apart from better quantitative estimation of the available bone dentascan also provides density of the available bone at implant site which cannot be assessed by panoramic radiography.

4. Discussion

Oral implants have become a common method of treatment for both completely and partially edentulous patients. The successful placement of implants requires careful pre-operative radiographic examination as an adjunct to clinical examination. Thus, it is necessary to use imaging techniques that accurately determine the size and location of structures such as mandibular and incisive canals, maxillary sinus, nasal fossa, density of alveolar ridges and cortical plates at the proposed site for implant placement.[10] In the posterior part of mandible it is necessary to determine the amount of bone superior to mandibular canal. The length of implants in the posterior region of mandible is chosen according to the amount of bone available superior to inferior alveolar canal, to avoid trauma to inferior alveolar nerve.[11,12] Trauma to inferior alveolar nerve may lead to severe hemorrhage and neurosensory deficits over the distribution of inferior alveolar nerve[13].

Conventional panoramic radiography is still, the most commonly used imaging modality to localize the mental foramen and the mandibular canal for the preimplant treatment planning in the posterior mandible, but the mandibular canal is often difficult to locate in these regions with this technique. On panoramic

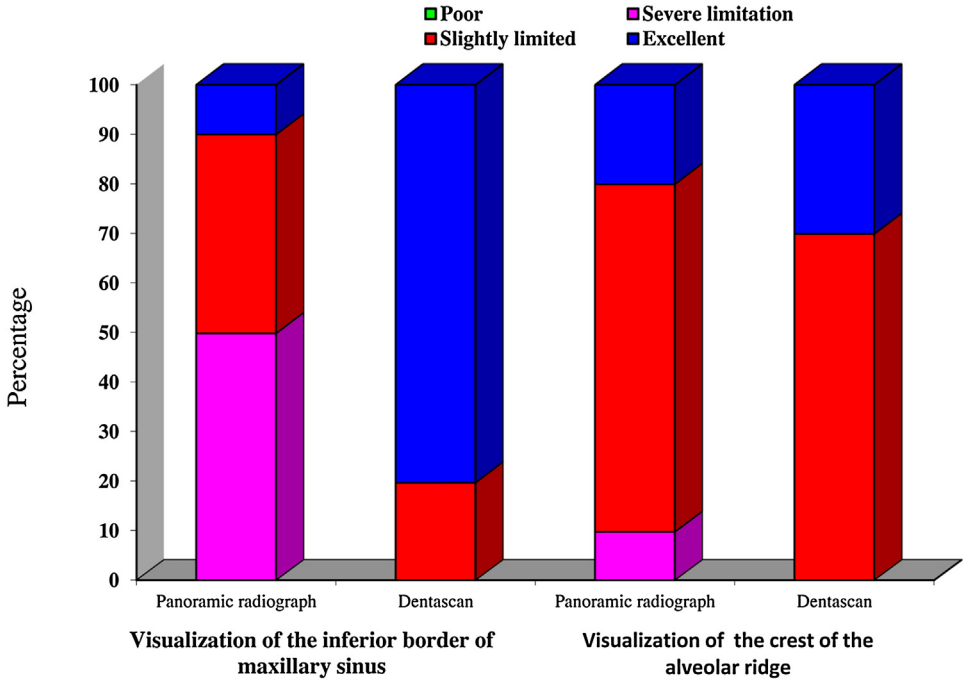

Fig. 1. Distribution of the grading score for visibility of vital structures in the maxilla.

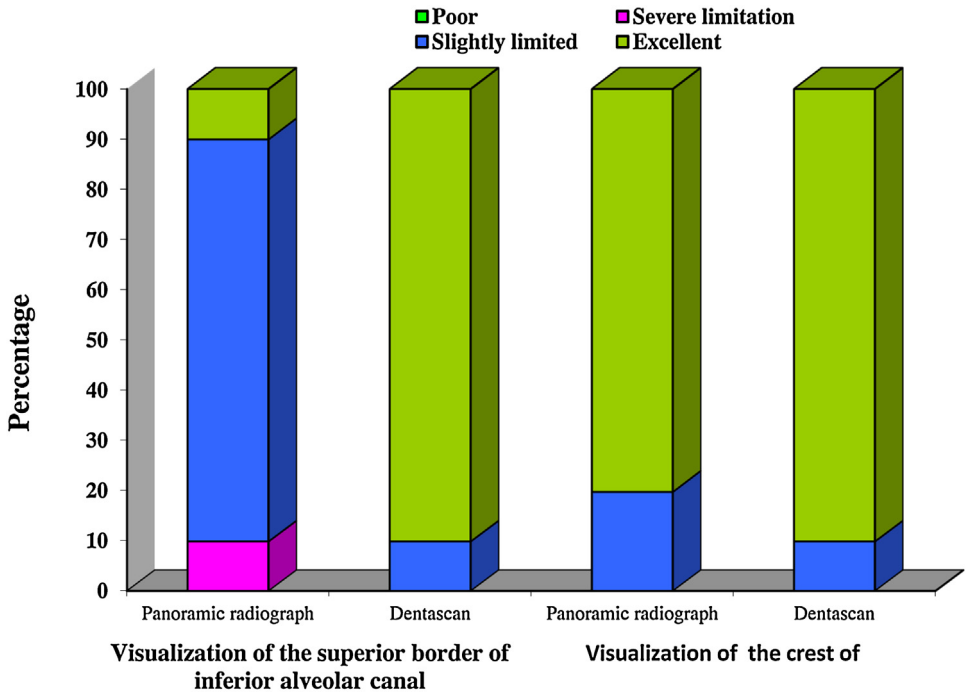

Fig. 2. Distribution of the grading score for visibility of vital structures in the Mandible.

radiographs the mandibular canal is visualized in the ramus and in the molar regions. In our study the conventional panoramic radiography showed markedly lower percentage of excellent image at the region 1 cm posterior to the mental foramen than other regions.[4]

The high number of not visible canals recorded for conventional radiographic method is probably related to the fact that the inferior alveolar nerve bundle is not always surrounded by an ossified canal. The bony sheath looks to disappear anteriorly towards the mental foramen[7]. However the present study showed that computed tomography gave a better degree of visualization of the vital structures (maxillary sinus/inferior alveolarcanal) than panoramic radiography. Apart from the better visualization of the vital structures the CT have the advantage over panoramic radiography in that it does demonstrate the buccolingual location of the inferior canal, in addition to the vertical distance from the crest. In one of the patient placement of implant was deferred due to inadequate width of the buccolingual bone available, though the patient had adequate vertical bone height for implant placement as depicted by the panoramic radiograph. In addition, the images of the trabecular pattern, cortical plates and bone margins were all clear in the CT.

In the present study Dentascan (Computer tomography software program developed by General Electricals, Milwaukee, WI, U.S.A.) was used to assess the quantity and quality of the bone. The Dentascan is a software program that allows the mandible and the maxilla to be imaged in three planes: axial, panoramic, and cross sectional. It has been widely used pre- operatively for implant surgery as it provides a comprehensive assessment of the morphology and measurement of the dental implant site[14]. The software also provides the valuable information regarding the density of bone available at implant site, as the accurate information on bone density will help the surgeon identify suitable implant sites, and to predict the primary stability before the implant insertion, thereby improving the surgical planning and, eventually, the success rate of the procedures[15,16].

Any comparison of the radiation risk from CT with that from conventional panoramic radiography is problematic, but it would appear from the literature that clinician has to balance these risks against the benefit in planning dental implants. It is suggested that for routine cases where implants of satisfactory length can be inserted safely, panoramic radiographs are adequately accurate. But in cases where measured vertical height is inadequate and the option of interpolating the implant lateral to inferior canal is contemplated, CT scanning (Dentascan) serves the surgical team as comprehensive examination to achieve optimum results. The same considerations apply to implants located beneath the maxillary sinus.

Table 3
Comparison of Vital Structures at Implant Site in Panoramic Radiograph and Dentascan for Mandible

Vital structures		Poor (1)	Severe limitation (2)	Slightly limited (3)	Excellent (4)	Mean ± SD	P value
Visualization of the superior border of inferior alveolar canal	Panoramic radiograph	0	1 (10.0%)	8 (80.0%)	1 (10.0%)	3.00 ± 0.47	0.003**
	Dentascan	0	0	1 (10.0%)	9 90.0%)	3.90 ± 0.32	
Visualization of the crest of the alveolar ridge	Panoramic radiograph	0	0	2 (20.0%)	8 (80.0%)	2.80 ± 0.42	0.002*
	Dentascan	0	0	1 (10.0%)	9 (90.0%)	3.90 ± 0.32	

Conflict of Interest

The authors have none to declare.

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